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PROGRESS IN INTERNATIONAL METEOROLOGY[1]

By WILLIS RAY GREGG, Chief of Bureau

[Weather Bureau, Washington, December 1935]

The International Meteorological Organization (I. M. O.) provides one of the finest examples of international cooperation and good will that can be found anywhere. It can be said, without fear of contradiction, that the accomplishments of this organization in bringing about uniformity of practice have no parallel, either in scientific endeavor or in the fields of international politics and commerce. It is an interesting experience to participate in one of the conferences. There is an atmosphere of cordiality and friendship, combined with one of determination to reach a common viewpoint. This does not mean that the various national representatives accept, at once and without debate, the recommendations of committees appointed to consider certain questions of policy and procedure. On the contrary, individual opinions are freely expressed and vigorously defended, and the discussions may carry over from one conference to the next. But in the end, with rare exception, satisfactory agreements are reached and are put into practice.

There are two main reasons for this. First, meteorology is more completely international in its application to human activities than is any other science. The weather that one country has today is closely related to that of all adjacent countries and will be essentially the weather of some of those countries tomorrow. Hence, standardization in presenting the reports from all these countries for study by the forecaster is essential for their prompt and effective use. In the second place, every meteorologist recognizes so keenly both the very real inherent difficulties in making progress in the practical application of meteorological science, especially in the problems of forecasting, and also the enormous economic and other benefits that would result from such progress, that he is willing to submerge his own individual views in a common and united effort for the good of all.

HISTORY OF THE I. M. O.

Although several informal conferences of officials affiliated with Government-supported meteorological services were held in Europe during the early seventies, the International Meteorological Organization itself was first formed at Rome in 1879. Since that date there have been meetings at intervals averaging about 6 years. In the earlier ones, chiefly European services participated, but in the last two conferences, 1929 and 1935, about 40 countries took part, including many in the Southern Hemisphere. At the present time there are 105 meteorological or closely related scientific services represented in the organization. However, some countries have two or more such services, more or less independent although all supported by their governments, with the result that actually the membership of the organization now includes 54 countries.

From time to time commissions have been appointed to deal with specific phases of meteorological service. Although only directors of national services can be members of the parent organization, the commissions are composed of an unlimited number of technical employees of those services and also at times include a few outstanding scientists who have no official affiliations. Membership in these commissions, each of which includes 1 or more directors, now totals nearly 300 persons.

CLOUD ATLAS

The record of accomplishments during these 60 years is impressive. One of the most far-reaching was the organization of an intensive, world-wide study of clouds and cloud heights, and the selection of cloud forms and adoption of nomenclature which, with some minor changes have provided a guide to all national services and made possible ready and reliable comparison of cloud data from all parts of the world. Recently a revision has been made of the Cloud Atlas, embracing for the most part minor changes resulting from experience, but not appreciably altering the basic character of the original. The universal adoption of the new atlas seems assured.

POLAR YEAR PROJECTS

Another major achievement was the organization of two so-called Polar Year campaigns. In the first one, August 1882 to August 1883, inclusive, effort was directed chiefly to securing statistical data from a large number of points in high latitudes. There resulted a large body of very valuable information, mostly useful in theoretical studies. At that period no use of it could be made currently, since communication facilities in remote regions had not been developed. The second campaign, August 1932 to August 1933, inclusive, was more comprehensive, being world-wide in scope, and emphasizing the utility of the data in synoptic researches. Much attention was given also to upper air soundings throughout the world, particularly in polar and subpolar regions. It is too early to appraise fully the value of this project, but excellent progress is being made in compiling, charting, and summarizing the data, and it is the general view that results of far-reaching importance will come from studies of them, as soon as they are made available in published form.

[1] A report on the 1935 meeting of the International Meteorological Organization at Warsaw and on conferences at several leading meteorological offices in Europe.

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THE COPENHAGEN CONFERENCE

When the history of the International Meteorological Organization is written, the 1929 conference in Copenhagen will undoubtedly stand out as marking the beginning of a new epoch in international progress in weather service. Prior to that time effort had been concentrated largely on the standardization of methods of observation, nomenclature, and form of publication. Some attention had been given also to the exchange of current reports, but only on a rather limited scale, means of transmission not having then been developed to a point permitting anything like a comprehensive international service.

INTERNATIONAL EXCHANGE OF REPORTS

With the advances that have been made in radio, however, particularly during the past decade, the situation has been very completely changed. At the outset of its development, radio was recognized as constituting a powerful potential agency for bringing about the realization of a goal which meteorologists had been dreaming about for years, namely, the preparation day by day of weather maps, first for an entire hemisphere, and eventually for the entire world. Sporadic efforts to this end were made by different services, but a great multiplicity of codes grew up and many other difficulties arose, with the result that progress was slow. The problem was attacked in a most energetic way at the Copenhagen conference. It was recognized that greatest efficiency in international exchange could be attained only by simplification and standardization of methods along three principal lines, namely, codes, units, and symbols.

A uniform code is essential to overcome difficulties inherent in a diversity of languages. Happily, all countries use the same figures, and so a figure code has been adopted and is used in all international exchanges and will almost certainly, in the comparatively near future, be substituted for other codes by all national services.

The matter of units is not so simple. For example, English-speaking countries use the Fahrenheit scale for temperature, whereas nearly all others use the centigrade. Again, there are differences in measures of length, speed, etc. Complete uniformity cannot be realized unless and until some of the countries themselves officially change their units. However, uniformity has been effected to the extent that is possible at the present time.

Until recent years it was of little consequence whether or not the symbols on weather maps in one city agreed with those in another. Few people ever saw other than the maps issued in their own city. With the rapid development of aviation, however, the situation became completely changed. Pilots, and passengers too, are vitally interested in the weather and study the maps in great detail. In the course of a single trip they may see several different ones. It is essential for them that the symbols be uniform, not only at different points in the same country, but also in different countries; and this has now, in large part, been brought about.

Although the foundation, and a very substantial one, was laid at the Copenhagen conference, many details remained to be whipped into shape, and this work was largely accomplished at the recent conference in Warsaw. It is a notable achievement and, with the passage of time, will be increasingly recognized as marking a milestone in international meteorology, particularly in the prompt and accurate exchange of reports that is so necessary in forecasting for all activities, continental, aerial and marine. Credit goes to the members of the Commission on Synoptic Meteorology, and especially to its President, Col. E. Gold, of the British Meteorological Office.

THE WARSAW CONFERENCE

This conference was preceded by meetings of the Commission on Agricultural Meteorology and the Climatological Commission at Danzig. A brief report of the action taken by these commissions is given in this issue of the REVIEW by J. B. Kincer, who was the Weather Bureau's representative at these meetings.

AEROLOGY AND AERONAUTICAL METEOROLOGY

For the past 30 years, one of the most active commissions of the International Meteorological Organization has been the Commission for the Exploration of the Upper Air, now known as the International Aerological Commission. Its record has been one of outstanding achievement. It initiated and has supervised the so-called International Days program of upper-air soundings. Admittedly, it is very desirable to have such observations every day, but the cost is prohibitive in the case of nearly all national services; hence, it was decided to concentrate effort on securing world-wide simultaneous soundings on a few selected days each year. This program has yielded results of great value, vastly extending our knowledge of atmospheric structure and processes. Yet it is generally recognized that a mere beginning has been made. Methods of observation, highly ingenious and the best available at each successive stage in the development of this program, have always been and now are inadequate, giving us only partial, and in many cases not the really essential information. There has always been definite advance, however, and the recent Warsaw conference brought out conclusively that the curve of progress, heretofore gradual, is due for a marked upward jump in the relatively near future.

RADIO ASSUMES A NEW ROLE

In securing upper air data, kites, captive and manned balloons have had their day, pilot and sounding balloons and airplanes are having theirs now, but all are bound very shortly to give way to radio which will assume the twofold role of *observer* as well as transmitter of meteorological data.

The idea of utilizing radio for this purpose was first suggested some 15 to 20 years ago. Soon several investigators were working on the problem, and some preliminary tests were made as early as 1923 in the United States and 1927 in France. The first really successful results, however, were obtained at Slutsk, Union of Soviet Socialist Republics, in 1930, under the direction of P. A. Moltchanov. Since then progress has been rapid, a large number of reasonably satisfactory soundings having been made during the International Polar Year, 1932–33. At the present time daily records are being obtained at 10 stations in the Union of Soviet Socialist Republics, and nearly all other meteorological services are conducting researches for the purpose of developing apparatus which shall be considerably lighter in weight and less costly than any at present available. It is gratifying to be able to state that this country is taking a very active part in this investigation, particularly at the National Bureau of Standards, with the cooperation of the United States Weather Bureau, and at Blue Hill Meteorological Observatory.

A good indication of the importance that is attached to this matter is the adoption of a resolution by the Aerological Commission, designed, if possible, to bring about a standard type of instrument, thus reducing cost. The resolution reads as follows:

The Commission instructs its President to make inquiry of all services regarding pending construction of radio sounding balloons as a basis for standardization of the weight, as well as the price by single piece or by mass production. The result of this inquiry will be compiled by the Institute to provide data to advance and to direct the uniform development of the important radio sounding instruments.

All of this activity by many meteorological services is inspired chiefly by recent rapid developments along two lines: (1) The tendency to higher altitude flying, and the resulting need for *current* information on upper air conditions for use in determining the safest and most efficient flying altitudes. (2) The application of physical principles to the analysis of the weather map as a basis for prediction of future development and the resulting need for current information on upper air conditions as high up as possible, in all types of weather, on land and sea, especially in isolated regions not otherwise accessible.

The radio meteorograph, attached to a rubber balloon of the type and quality now available will meet these needs more completely than does anything else thus far devised. While still to some extent in the experimental stage, sufficient progress already has been made to assure a comprehensive program of upper air observations to great heights within the comparatively near future.

REVISION OF THE STATUTES OF THE I. M. O. TO MEET THE NEEDS OF AERONAUTICS

Several years ago it was recognized that there was need for an additional commission to consider the most effective application of weather service to the needs of aviation, and accordingly a Commission on the Application of Meteorology to Aerial Navigation was formed. In the meantime, however, other organizations dealing with aeronautics had come into being, particularly the International Commission for Air Navigation (C. I. N. A.) and the International Aeronautical Conference (C. A. I.), both of which had subcommissions dealing with weather service. There was need for a coordination of the efforts of these two and the older International Meteorological Organization, a need that has become increasingly apparent in the last few years.

Accordingly, one of the most important actions taken at the Warsaw conference was a revision of its statutes that made possible the formation of a commission whose membership will include representatives of other bodies dealing with the application of weather service to aeronautics. This revision was made by a special committee under the chairmanship of Sir George Simpson, Director of the British Meteorological Office. Other members of the committee were representatives of the meteorological services of France, Germany, Holland, Italy, New Zealand, Norway, Poland, and the United States.

The report of the committee was approved by the International Meteorological Organization. It provides that the membership of the new commission, which is known as the "Commission on Aeronautical Meteorology", shall consist chiefly of representatives, chosen by the various countries, who are recognized as experts in aeronautics and particularly in the relation of meteorology thereto. It is not necessary that they be members of the International Meteorological Organization. However, certain officials of the latter are authorized to attend meetings of the Commission in an advisory capacity, including particularly the presidents of the commissions on synoptic weather, upper-air investigations and maritime meteorology. Moreover, all resolutions adopted by the commission must receive the approval of the President of the International Meteorological Organization before becoming effective.

This action is an excellent illustration of the increasing recognition that is being given to aeronautics and its importance as a means of transportation. It marks a distinct step forward in assuring that everything possible will be done by all meteorological services to contribute their proper share in making flying safe and efficient.

LONG-RANGE WEATHER FORECASTING

This subject was not on the agenda of the conference at Warsaw, but there was opportunity to discuss it more or less informally with various delegates there and also in the course of visits to some of the leading meteorological offices in Europe.

Generally speaking, there was little evidence of optimism as the result of the extensive investigations thus far made. In many of the countries much research has been carried on during past years, and in some cases cycles or correlations have been established that seemed to give encouraging results for a few years, only to break down later with a succession of failures for a similar period. As a result, effort along this line has been largely abandoned in most countries, the exceptions being Germany and the Union of Soviet Socialist Republics. Time did not permit looking into the subject in Germany, but it was discussed during a brief stay in Leningrad, chiefly by Mr. Kincer, from whose report the following excerpts are taken:

The Union of Soviet Socialist Republics has a separate institute at Leningrad for long-range forecasting, officially designated "The Institute of Long-Term Weather Analyses", at which weekly forecasts are regularly issued covering a month in advance. They are also experimenting with longer time, or seasonal, forecasts, but the work in this respect has not developed to the phase of official predictions.

In general, the method used in their weekly forecasts is based on normal seasonal synoptic charts, or the averages of movements, behavior, and resulting weather of cyclones and anticyclones (in family relations) as determined from their life histories over a long period of years. As a basis for operations they have charted the paths of HIGHS and LOWS, by seasons, from 1881 to 1933, from which the most frequented paths are considered as normals for the several seasons, and the life histories, after appearing on the synoptic charts from day to day, were determined as a guide for predicting the results of comparable conditions that may be in evidence at the time the forecast is made. For preparing the normal charts, definite dates were not used to represent the different seasons, such as December–February for winter, etc.; but rather, the limits of the cold season, for example, were fixed from an arbitrary determination of the beginning of the first definite cold wave of winter to the last for that season. These vary from year to year and differ considerably in different years.

In determining the life history of a cyclone or an anticyclone the month was divided into four parts, representing four successive weeks subsequent to the appearance of the cyclone or anticyclone, and the average condition for each of these periods was used as a base in making the current successive weekly forecasts.

In some cases forecasts for the successive weeks are for the week as a unit, while in others the week is divided into the first and second half. Forecasts are made for 28 different regions and, in general, are expressed in broad terms.

For verification purposes, all forecasts appearing on the chart are used instead of verifying individual districts separately. A specified tolerance is allowed for these verifications; a time leeway of four days, two on each side of the week's range, and a temperature tolerance of 2° C. on each end of the scale. That is, instead of the 7-day period specified in the forecast, if the forecast is verified for any 7 days within an 11-day period, the specified 7 days plus 2 days preceding the week or 2 days following, and

if the temperature did not vary more than 2° C. from the limits forecast, verification is credited. However, in the case of temperature, if any station shows a disagreement beyond the tolerance allowed the entire forecast is counted as a failure. The basic temperature range as forecast is usually about 7° C., plus 2° C. tolerance for verifying purposes. For example, the forecast for the week July 16–22, 1935, reads "Temperature of the whole period in the limits of 14–7° C."

This constitutes a serious effort to accomplish something definite in the highly difficult task of extending the period of forecasts. It has been in operation too short a time to make possible an appraisal of its dependability and value, but it will be watched with keen interest and with the hope that its continued use will be justified.

CONCLUSIONS

During the past decade international meteorology has made advances that are without parallel in the previous history of the science. Progress has been marked both in theory and in practical application to human activities, particularly to agriculture, engineering, hydrology, and marine and aerial navigation. Chief contributors to this progress are the standardization of methods of international exchange of continental and marine reports, the development of improved technique in upper-air exploration, and the application of well-established physical laws to forecasting. The increasing dignity, respectability, and efficiency of meteorological service generally are due in no small measure to the inclusion of advanced training courses in this subject in the curricula of leading educational institutions in many countries. With these factors as a ground work, we look forward, with confidence, to the building up of an ever increasingly efficient service, contributing its proper share to progress in the economic, commercial, and social life of the world.

THE DANZIG MEETINGS OF THE INTERNATIONAL CLIMATOLOGICAL COMMISSION AND THE COMMISSION ON AGRICULTURAL METEOROLOGY

By J. B. KINCER

[Weather Bureau, Washington, December 1935]

At the meetings of the International Climatological Commission and the International Commission on Agricultural Meteorology at Danzig on August 28–31, 1935, a number of important matters relating to international climatology and agricultural meteorology were considered.

Among these may be mentioned definitions of symbols for use in climatological publications; letter symbols for representing the divisions of the day; international exchange by radio of monthly means of pressure, temperature and precipitation; the publication of climatological data by pentad means in addition to monthly means; the best period to be covered for "standard means" or normals, from which to compute departures for individual months and for the year, etc.

With regard to the matter of symbols, Dr. Bergeron, formerly of the Norwegian Meteorological Service, but more recently with the Swedish Service at Stockholm, presented an eleborate series of definitions of hydrometeors with a proposal that the Climatological Commission recommend their adoption by the International Organization. In addition to symbols to represent the various meteorological phenomena, his proposal was to add rather extensive definitions to cover, in many cases, the dynamical processes considered responsible for their development. The British, Canadian, and United States delegates offered opposition to this, especially with regard to the definitions, contending that symbols should merely represent, or stand for, the several phenomena and that no theory as to how they are developed dynamically should be included. Also, in some cases, his scheme was unsatisfactory to the Americans because of a difference in nomenclature: For example, sleet was defined as "precipitation of melting snow, or of snow and rain mixed", whereas in Canada and the United States sleet is an entirely different thing. After much discussion it was evident that no agreement could be had, and a motion was made and carried to refer the entire subject to a joint committee, composed of the Climatological Commission and the Commission on Synoptic Weather, to be held at Warsaw prior to the Directors' meeting. At Warsaw the matter was again considered, with the result that the original proposal was modified in a way that largely sustained the views of the American and the English delegates. Also, a proposal to remove drizzle from the category of rain, distinguishing it as a separate phenomenon, was met by opposition from the English and the American delegates, and was not approved.

Recommendation for a rather important change in thunderstorm symbols was made, the following being adopted: ⌈⟍, thunderstorm, including rain, at station; (⌈⟍), distant thunderstorm (observed from, but not occurring at, the station); and ⟍, distant lightning without audible thunder.

The matter of letter symbols to designate meridian divisions of the day was considered. The designations heretofore used by the Weather Bureau include "a" for before noon; "p", afternoon; "dnp", during the night before midnight; and "dna", during the night after midnight. Several delegates desired to establish definite hours to which the symbols should apply, such as: "np" to represent the period between 9 p. m. and midnight, and "na", between midnight and 3 a. m. The following were finally recommended: "a", before noon; "p", afternoon; "n", nighttime; "np", nighttime before midnight; and "na", nighttime after midnight, without definite time divisions. It may be noted that this conforms to Weather Bureau practice, except in minor details which have been changed to effect entire agreement.

Closely allied to this was the matter of letter symbols to designate the official elevation of meteorological stations and instruments. Some changes were made in the heretofore international designations, with adoption of the following: H, elevation above sea level of the ground at the station, to be considered the official elevation of the station; H_b, elevation of barometer cistern above sea level; h_t, thermometer above ground; h_a, anemometer above ground; h_d, wind vane (wind director) above ground; and h_r, rain gage above ground. This, in general conforms to present Weather Bureau practice, except that no designation for H has been carried in this country, the official station elevation being that for the barometer above sea level as of the epoch 1900, or the actual barometer elevation for stations established since that time. This requires a change in Weather Bureau practice, and action already has been taken to bring our records into line with the agreement, beginning January 1, 1936.